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Evaluation of Alternative Geometry for TASD

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ABSTRACT

We consider a somewhat different geometry for TASD, ie 15m long extrusions and 7mm diameter fibers. Such a geometry might make the handling issues somewhat easier. The cost and physics performance of such an arrangement are very comparable to the one previously discussed, ie 17.5m long extrusions and 8mm diameter fibers. Thus it appears that the parameters chosen are on a rather broad optimum.

Introduction.

We have previously suggested a Totally Active Scintillator Detector with 17.5 m long extrusions and fiber diameter the same as for the baseline detector, ie 0.8 mm. The longer cell size might make some of the handling issues eg. assembly in factories, transportation and installation somewhat more complicated and hence might introduce some hidden costs. Thus it appears useful to examine cost and performance of a detector of the same mass but with shorter cell sizes. The specific model we consider is 15m long extrusions which would correspond to 12 (rather than 14) extrusions per plane if the same cell dimensions are maintained. Because light attenuation would be less, one might consider smaller diameter fibers to offset some of the increased costs. We choose 0.7mm diameter fibers in this model.

Cost Comparison

We maintain the same mass, ie the same volume of the detector. This gives a detector 122.5m long as compared to 90m for the baseline. The number of extra extrusions will scale as the cell length, ie will be 7/6 larger. We consider different components and give our rationale for cost differential quoted. Cost differential is positive if the smaller dimension detector is more expensive. All costs used are fully burdened.

Fiducial volume and leakage. We need to compare detectors giving the same number of oscillated ν_e events passing the fiducial volume cuts. Based on simulations with the original detector, the new one will have fiducial volume .33 % larger. Assuming that $125M is the cost that scales with mass, this will give a net cost differential of -$411K.

Fibers. The required fiber length in the new geometry is very similar, the only increment being the extra 2m per cell in the manifold, ie +$159K.

Thinner fibers. Assuming that the fiber cost scales with the volume, going to 7mm diameter from 8mm will give a saving of $3953K.

APD's. The cost will scale with the number of channels ie be 7/6 times larger. That will increase the cost by $531K.

Boxes. These will scale (for material and production labor) also as the number of channels, resulting an additional cost of $1277K.

Modules. The extra cost will be due to additional ends for more units. We assume that extrusion cost scales as the mass of the PVC and thus will remain the same. This will give an increment of $370K.
Installation. We assume that the installation cost differential is due to extra labor which we take as proportional to number of extrusions. That gives a cost increase of $723K.
Building. John Cooper ran the new detector through the FESS algorithm which gave a cost higher by $520K for the new detector (unloaded). Gina's algorithm inflates that cost by 2.343 to allow for EDIA, indirects, and contingency. This gives a total cost increase for the building of $1218K.
Cost summary. Summing up all all the positive and negative costs we obtain a cost increase for the new geometry of $1227K, ie less than 1% of the total cost. This is probably an overestimate since we have nowhere allowed for potential cost savings due to the fact that extrusions are shorter. This may allow unaccounted for cost savings in setting up of factories, in transportation, and in installation.

Performance Comparison

I have compared, using Keith Ruddick's modified program, the light output for thinner and shorter fibers with the original ones. The 0.7mm shorter fibers give light output 8.3% higher at the far end and 10.7% lower at the near end. Thus the light output is more uniform and higher at the more crucial far end. Thus from the light output point of view the new geometry would be slightly preferable.

Conclusions

The modified geometry appears to give a slightly higher cost and slightly better light output performance. The slight cost increase may turn out not be significant once second order effects are taken into account. Thus it appears that there is some flexibility in the choice of parameters.